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Track-bridge interaction effect on the train-bridge resonance of railway viaducts

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Abstract:

As demand is increasing on high speed railway lines, proficient and cost-effective design of these vital transportation infrastructures is well expected with ever augmenting traffic speed. The dynamic response of bridges with ballasted track is known to be very dependent on several factors. These may influence largely the response of such composite structures under circulating loads. The interaction occurring in the system is function of the bare bridge track modal properties. But, it is also influenced by the track superstructure including rails, sleepers and ballast. For simply supported (SS) bridges or viaducts which are generally susceptible of experiencing high vibration levels, one of the most demanding requirements for their design is the vertical accelerations and it constitutes one of the Serviceability Limit States for traffic safety prescribed by Eurocode (EC) [1]. Track-bridge interaction influences the dynamic behavior of the structures mentioned above, valuable research has been achieved in this field as indicated from recent literature [2-5]. One of the most successful approaches rendering the essential of ballast-bridge interaction is based on modeling the bridge and the track as two-layer beams connected between them through springs and dampers representing the nonlinear friction behavior occurring at their interface. Experimental evidence has enabled the merit of this approach.

The aim of the work is to analyze the effect of the nonlinear behavior of the ballasted track on the train-bridge resonance of a simply supported single track railway bridge. The studied bridge traversed by moving trains is modeled by two layers beams connected between them through a nonlinear Kelvin-Voight viscoelastic foundation. This approach enabled to account in an efficient way of the ballast effect on the global bridge dynamics under all the high speed load models (HSLM). The obtained results have shown that the dynamics of the system is governed essentially by a Duffing like oscillator where a decreasing in the bridge frequency is observed.

Keywords: Railway bridges, resonance, ballasted track, vertical acceleration.

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